MAP GQ–1651

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOLOGIC MAP OF THE BULL BASIN QUADRANGLE, CATRON COUNTY, NEW MEXICO

By James C. Ratté

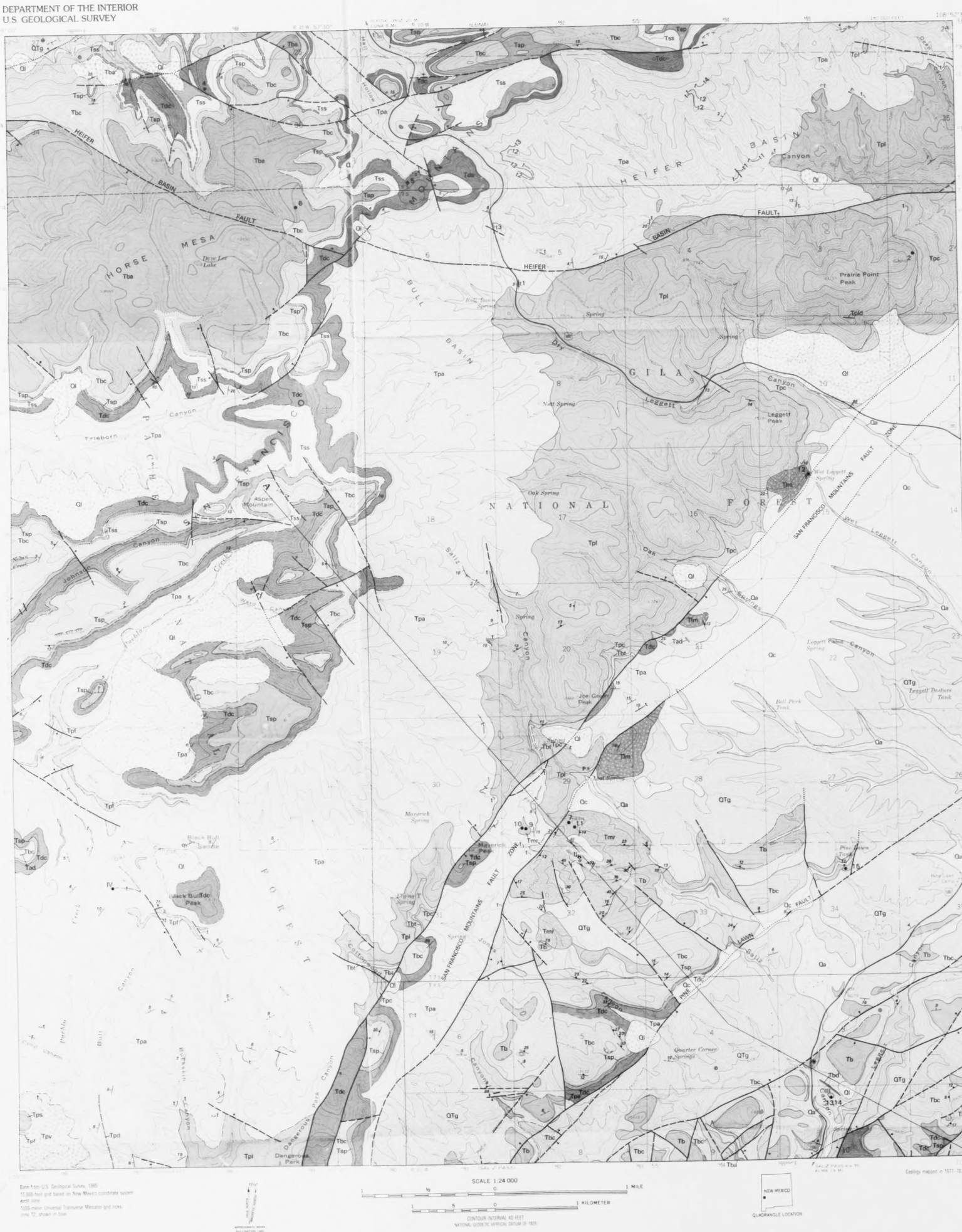
GEOLOGIC QUADRANGLE MAP
Published by the U.S. Geological Survey, 1989

NEW YORK
JUN 19 1989
STATE LIBRARY

RATTÉ—GEOLOGY, BULL BASIN QUADRANGLE, NEW MEXICO 1:24,000 MAP GQ–1651

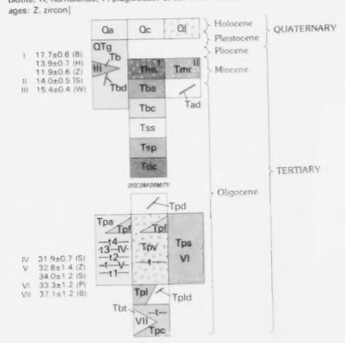
best copy available

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY



CORRELATION OF MAP UNITS

[Roman numeral indicates dated unit; Ages in millions of years. K-Ar ages: B, biotite; H, hornblende; P, plagioclase; S, sanidine; W, whole rock. Fission-track ages: Z, zircon]



DESCRIPTION OF MAP UNITS

Qa **Alluvium (Quaternary)**—Holocene stream deposits a few meters thick; includes sheetwash deposits locally

Qc **Colluvium (Quaternary)**–Sheetwash deposits and talus; mapped mainly where it obscures bedrock along the San Francisco Mountains fault zone near Wet Leggett Spring. Maximum thickness probably less than 10 m. Slumped locally and gradational with landslide deposits

Ql **Landslide deposits (Quaternary)**—Obscure bedrock in extensive areas, particularly along Pueblo Creek, Frieborn Canyon, and the north wall of Dry Leggett Canyon

QTg **Gila Conglomerate (Pleistocene, Pliocene, Miocene, and Oligocene?)**—Mainly buff to pinkish-brown to gray conglomerate and sandstone; consists of locally derived volcanic clasts and has sedimentary structures, such as crossbedding and scour and fill channels, characteristic of fluvial deposits. Interbedded basaltic lava flows (Tb) of early to middle Miocene age are probably indicative of the age of most sedimentary deposits in this quadrangle, but do not restrict their age from ranging more widely. Basalt flows less than 3 million years old are interlayered in Gila Conglomerate in adjoining Luna quadrangle (T. L. Finnell, oral commun., 1985), and 1-million-year-old basalt is interlayered in the conglomerate in nearby Squirrel Springs Canyon quadrangle (Bikerman, 1972). Commonly overlies Miocene and (or) Oligocene Bearwallow Mountain Andesite and thus may be partly Oligocene in age. Occurs mainly east of San Francisco Mountains fault zone in this quadrangle. Maximum thickness is about 200 m

Tmr **Porphyritic quartz diorite of Wet Leggett Spring (Miocene)**—Three small hypabyssal intrusions of hornblende quartz diorite (analysis 12, fig. 2 and table 1) occur along San Francisco Mountains fault zone between Wet Leggett Spring and Lost Spring. All three bodies contain an assemblage of phenocrysts that constitutes about 25 percent of the rock and is distinctive for this area. Phenocrysts include faintly pink, rounded, xenocrystic(?) quartz as much as 0.5 cm or larger, commonly with corroded margins or pyroxene reaction rims (7 percent); euhedral green-black hornblende (1–3 mm; 3 percent) and brown biotite (less than 1 mm; 1 percent), both having reaction rims of iron oxide granules; strongly zoned and somewhat rounded oligoclase-andesine (1.5–2 cm; 12 percent) and accessory sphene and zircon. Tiny pyroxene and iron oxide granules are scattered throughout the fine-grained, microlitic to granular matrix of plagioclase, alkali-feldspar, quartz, and (or) tridymite. Stock west of Wet Leggett Spring contains both coarse-grained and fine-grained cognate inclusions, which contain as much as 23 percent hornblende and 4 percent opaque oxide phenocrysts in a granular to granophyric quartz-feldspar matrix. K-Ar ages (biotite, 17.7±0.6 m.y. (million years); and hornblende, 13.9±0.7 m.y.) and a fission-track age (zircon, 11.9±0.6 m.y.) (Marvin and others, 1987) were obtained from a sample of stock at Wet Leggett Spring

Tmr **Rhyolite east of Maverick Peak (Miocene)**—Small rhyolite plug exposed about 0.7 km northeast of Maverick Peak may have been source for domal rhyolite flows preserved on downthrown side of San Francisco Mountains fault zone. Analyzed samples from the plug and adjacent flows range from rhyodacite vitrophyre to high-silica alkali rhyolite (analyses 7–11, fig. 2 and table 1). Also contains high beryllium (5–10 ppm), rubidium (246–347 ppm), yttrium (50–82 ppm), niobium (70–94 ppm), and fluorine (2,100 ppm in sample 7). Both rhyodacite vitrophyre and felsite contain about 15 percent small (1–2 mm) phenocrysts and microphenocrysts. The black vitrophyre has about 6 percent quartz, 6 percent oligoclase, and 2–3 percent sanidine. The light-gray to lavender or reddish-gray felsitic rhyolites have 6–9 percent quartz, 3–4 percent oligoclase, and 2–5 percent sanidine. Accessory minerals include rare biotite, opaque oxides, and pyroxene. Rhyolite plug has fine-grained, granular matrix, notably coarser grained than flows. Flows locally contain as much as 5 percent andesitic(?) and other volcanic rock fragments, which may partly account for the less silicic composition of the vitrophyre. A K-Ar sanidine age for the rhyolite is 14.0±0.5 m.y. (Marvin and others, 1987). Domal flows are at least 100 m thick

Tb **Basalt lava flows (Miocene)**—Interbedded with Gila Conglomerate. Generally dark gray, fine-grained to sparsely porphyritic, tholeiitic olivine basalt (analyses 13–14, fig. 2 and table 1). Characteristically have a few scattered plagioclase phenocrysts as much as 1 cm long, but consist largely of microphenocrysts of plagioclase (andesine-labradorite), and olivine and clinopyroxene, generally less than 0.25 mm. Textures range from microdiabasic to microlitic and microgranular mixtures of plagioclase, olivine, pyroxene, and opaque oxide. Light-brown biotite is a rare, but characteristic constituent of these basalts, which contain about 1 percent K_2O. In Saliz Canyon a small, partly exhumed cinder cone is exposed along U.S. Highway 180 at junction with road to Pueblo Park in SW sec. 3, T. 8 S., R. 20 W., below the highway, cinder and bomb layers are cut by a dike which is probably the feeder for adjacent basalt flows. Basalt flow at age locality (II) provided a K-Ar, minimum whole-rock age of 15.4±0.4 m.y. (Marvin and others, 1987). Flows range from 0 to about 60 m thick

Tbd **Basaltic dike (Miocene)**—Dike associated with cinder cone along U.S. Highway 180 probably is a feeder for adjacent basalt flows (Tb)

Tba **Bearwallow Mountain Andesite (Miocene and (or) Oligocene)**—Dark-gray, fine-grained, highly vesicular to amygdaloidal, basaltic andesite flows (analysis 6, fig. 2 and table 1). Overlies Bloodgood Canyon Tuff on Horse Mesa in northwest corner of quadrangle. Consists of olivine microphenocrysts as long as about 0.5 mm in a matrix of partly aligned calcic labradorite microlites about 0.3 mm long, and dark interstitial glass. Distribution and thickness of about 100 m on Horse Mesa indicate a local source although no vents or dikes were observed in that area

Tad **Andesitic dike (Miocene or Oligocene)**—Small andesitic dike cuts Bloodgood Canyon Tuff near west edge of quadrangle, northwest of Black Bull Peak

Tbc **Bloodgood Canyon Tuff (Oligocene)**—Gray to light-gray, densely welded to partially welded, ash-flow tuff outflow sheet from Bursum caldera in Mogollon Mountains (Ratte and others, 1984) 40 to 50 km to the southeast. Where densely welded, tuff has strong lithophysal compaction foliation and consists of about 10–20 percent phenocrysts of sanidine (variety, mesostrene), quartz, sphene, and rare biotite, plagioclase, and zircon. Maximum thickness of about 100 m in southeast part of quadrangle, thins to 40–60 m in northwest part

Tss **Volcaniclastic sandstone (Oligocene)**—Red to brown, buff, and light gray, separates Bloodgood Canyon Tuff and Shelley Peak Tuff and Davis Canyon Tuff in northwest part of quandrangle. Characterized locally by large scale crossbeds of probable eolian origin; beds of concretionary sandstone have concretions as much as a few cm in diameter. Maximum thickness is about 60 m. Pinches out to south and east, not shown in Saliz Pass quadrangle (Ratte, 1980) where unit is too thin and discontinuous to be shown at 1:24,000 scale

Tsp **Shelley Peak Tuff (Oligocene)**—Characteristically brick red, phenocryst-rich, densely to partially welded, rhyolitic ash-flow tuff outflow sheet from Mogollon Mountains volcanic source area to southeast (Ratte and others, 1984). Tuff consists of 10–20 percent phenocrysts, mainly plagioclase and minor black to coppery biotite. Accessory minerals include characteristic green augitic pyroxene, which is usually visible in hand specimens, and opaque oxides, as well as traces of zircon, sphene, apatite, and hornblende. About 20 m thick in much of quadrangle, but pinches out locally in northwest part. May be in direct contact with underlying Davis Canyon Tuff and (or) overlying Bloodgood Canyon Tuff, or may be interlayered with volcaniclastic sandstone (Tss) in northwest part of quadrangle

Tdc **Davis Canyon Tuff (Oligocene)**—Light gray to nearly white, reddish brown near top, densely welded to partially welded, rhyolite ash-flow tuff outflow sheet, probably from Mogollon Mountains volcanic source area to southeast (Ratte and others, 1984). Deposited disconformably on an erosional topography of low relief on older andesitic volcaniclastic rocks and lava flows. The rhyolite to high-silica rhyolite tuff (analyses 4–5, fig. 2 and table 1) has characteristic white to brown, stringy pumice several centimeters long and typically contains about 3 percent tiny phenocrysts and microphenocrysts (maximum 1–2 mm), mainly sanidine, and traces of quartz, plagioclase, biotite, and opaque oxides, in a finely granophyric, vitroclastic matrix. However, the upper part contains 7–13 percent phenocrysts, including sanidine (5–9 percent), plagioclase (1 percent), and traces of quartz, green pyroxene, biotite, opaque oxide, sphene, hornblende, and zircon, and 1–4 percent foreign lithic fragments. Thickness ranges from less than 20 m to more than 100 m; thickness variations are greatest in northwest corner of quadrangle, due partly to irregularity of underlying erosional topography and partly to regional thinning in that direction

DATIL GROUP

[Includes all rocks beneath erosional unconformity at base of Davis Canyon Tuff in this quadrangle. Elsewhere, Datil Group is underlain by Eocene Baca Formation (Osburn and Chapin, 1983, Cather, 1982); lowermost part of Datil Group exposed in this quadrangle may be transitional to Baca Formation]

Pueblo Creek Formation (Oligocene)—Mainly an andesitic complex consisting of a proximal or vent facies of agglomerate, lava flows, and volcanic mudflow breccia peripheral to multiple eroded volcanic centers (stratovolcanoes) in the western Mogollon-Datil volcanic field. Distal, or alluvial, facies of volcanic conglomerate and sandstone forms apron gradational with vent facies. Volcaniclastic rocks in basal part of formation include beds that have abundant rounded clasts of pre-Tertiary sedimentary rocks, as well as volcanic clasts. Together, Pueblo Creek Formation and interlayered ash-flow tuff formations (Tbt, t1–t4, and others) constitute Datil Group in this area

Tpa **Alluvial facies**—Typically maroon to pink, interlayered volcaniclastic debris flows, conglomerates, and sandstones in southwest part of quadrangle change to more variegated gray to buff in north part. Debris flows in southwest part have porphyritic andesite blocks 3–4 m in diameter and grade southwestward into vent facies rocks; northward, debris flows are generally finer grained, but lava blocks 1 m in diameter are still common in Heifer Basin. Coarse detritus gives way to buff and red crossbedded sandstone and interlayered conglomerate in upper parts; these weak beds form extensive landslides along Pueblo Creek, Frieborn Canyon, and elsewhere. Contains interlayered tuff formations (t). Thickness about 300 to 350 m

Tpv **Vent facies**—Gradational with alluvial facies. Mapped only southwest of Pueblo Creek in southwest corner of quadrangle where vent facies consists partly of ropy, scoriaceous, glassy breccia, derived perhaps from the Saddle Mountain eruptive center in northwest corner of Saliz Pass quadrangle (Ratte, 1980), and southeast corner of Blue 15-minute quadrangle. Contains interlayered tuff bed (t)

Tpl **Andesitic lava flows**—Interlayered locally with both alluvial and vent facies. Flows shown on map may include several thin flows separated by thin volcaniclastic beds, as in places along upper Pueblo Creek. Flows range from dark-gray porphyritic lavas having conspicuous black pyroxene phenocrysts, 5–10 mm long, to finer grained flows with sparse small oldingsite and light-green altered pyroxene. Thickness a few meters to a few tens of meters

Tpd **Andesite dike**—Dike having dark pyroxene phenocrysts trends NNW in southwest corner of quadrangle, east of Saddle Mountain; extends more than 4 km to south in Saliz Pass quadrangle (Ratte, 1980), where dikes of similar trend contain hornblende phenocrysts as long as 1 cm. Thickness of dike 2–3 m

Tps **Andesite flows of Saddle Mountain**—Dark-gray, finely porphyritic flows extend into southwest corner of quadrangle from adjacent Saddle Mountain eruptive center. Flows contain sodic andesine phenocrysts (25–30 percent) with characteristically abundant glass inclusions, and highly oxidized ferromagnesian and opaque oxide phenocrysts (13–17 percent) in a dark, fine-grained, microlitic to granular matrix. Relict crystal form and rare unaltered cores indicate that hornblende was the most abundant mafic phenocryst, but rare unaltered grains and partly altered crystals of hypersthene and augitic pyroxene are at least minor constituents. Specimens closer to eruptive center, 0.5 km west of Bull Basin quadrangle, contain numerous, probably cognate, inclusions having dimensions of several centimeters and fine- to medium-grained granitic textures. Coarser grained inclusions consist of quartz, very finely twinned plagioclase, altered biotite, opaque oxides, and minor pyroxene in a hypautomorphic granular texture. These quartz diorite inclusions indicate at least some coarser grained intrusive rock beneath the Saddle Mountain eruptive center. Saddle Mountain flows have given a K-Ar plagioclase age of 33.3±1.2 m.y. (Marvin and others, 1987). Thickness about 60 m

Tpl / Tpld **Andesite flows of Dry Leggett Canyon**—Thick, gray to reddish-gray, porphyritic flows (analysis 2, fig. 2 and table 1) underlie main volcaniclastic sequence (Tpa) throughout quadrangle. Flows are 200–300 m thick across Dry Leggett Canyon near Leggett Peak and Prairie Point Peak, but thin to less than 100 m to the southwest at Cottonwood Canyon, where they are locally cut out by San Francisco Mountains fault. Porphyritic andesite flows reappear in Dangerous Park at south edge of quadrangle, where they thicken again, perhaps having accumulated in a local dome. Otherwise, a small dike (Tpld) south of Prairie Point Peak is the only indication of a vent for these flows. Specimen from near base of flows east of Prairie Point Peak has about 40 percent phenocrysts and microphenocrysts in a very fine microlitic to granular matrix. Phenocrysts are plagioclase (calcic-andesine) (31 percent), augitic pyroxene (3.4 percent), opaque oxides (3.2 percent), and altered mafic phenocrysts (biotite?, ortho-pyroxene, 4.5 percent). Another specimen from massive, locally columnar-jointed flows in Dangerous Park contains about 24 percent plagioclase (andesine-labradorite) and about 3 percent pyroxene, opaque oxides, and altered mafics in a pilotaxitic matrix. Sharply twinned clear plagioclase phenocrysts and even texture of these flows contrasts with seriate porphyritic flows at Prairie Point Peak

Tpc **Volcaniclastic rocks**—Beneath andesite flows of Dry Leggett Canyon contain beds having well-rounded cobbles and boulders as much as 20 cm in diameter of fossiliferous Paleozoic limestone and pink Precambrian gneiss and granite. Beds containing pre-Tertiary clasts generally are in upper part of sequence, not far beneath overlying lava flows (Tpl). Some volcaniclastic layers contain small limestone clasts and lenses of black glass, as though fused by flows directly above them. Bedded pyroclastic fallout and reworked ash beds (t), a couple of meters thick, also occur locally northeast of Prairie Point Peak. Base of unit apparently is not exposed in this area but may be transitional to Eocene Baca Formation Conglomerate is structurally weak and commonly involved in landslides on over-steepened slopes along Dry Leggett Canyon and elsewhere. East of Prairie Point Peak, exposed thickness is about 200 m

t1 / t2 / t3 / t / t4 **Tuffs (Oligocene)**—Several thin discontinuous tuffs are interlayered with alluvial facies (Tpa) and volcaniclastic rocks (Tpc). Generally are partially welded or indurated pyroclastic flows, some of which are tentatively identified as distal deposits of regional, caldron-forming ash-flow tuff sheets. Locally consist of pyroclastic fallout and reworked pyroclastic beds. In Heifer Basin, north of SU Canyon, in northeast part of quadrangle, tuffs are numbered t1, t2, t3, and t4. Tuffs t2 and t3 are also identified farther west at head of Heifer Basin, but further study is necessary to confidently correlate discontinuous tuffs throughout quadrangle. Tuff t3 (8.2 m thick in this quadrangle) is as much as 1 m thick in Luna quadrangle to north (T. L. Finnell, oral commun., 1986), where a sanidine concentrate has given a K-Ar age of 31.9±0.7 m.y. (Marvin and others, 1987). Preliminary paleomagnetic data (W. C. McIntosh, oral commun., 1987) is consistent with correlation of tuff t3 with Hells Mesa Tuff of Osburn and Chapin (1983). Tuffs t1 and t2 may correlate with other tuffs of the Datil Group described by Osburn and Chapin (1983)

Tbt **Tuff of Bishop Peak(?) (Oligocene)**—Red to gray, pumice-rich, ash-flow tuff interlayered in upper part of volcaniclastic rocks (Tpc) beneath andesite lava flows of Dry Leggett Canyon (Tpl). Tuff is exposed only in upthrown block of San Francisco Mountains fault zone from south of Oak Spring Canyon to Cottonwood Canyon. Densely welded tuff is characterized by coarse reddish-brown and gray pumice blocks as much as 20 cm long and a few centimeters thick; pumice is commonly porous and voids are lined with vapor-phase crystals. Tuff contains about 5–10 percent phenocrysts, mainly plagioclase and minor biotite and opaque oxides. Typical fresh tuff of Bishop Peak, in type locality in Underwood Lake quadrangle (T. L. Finnell, oral commun., 1984) has a plagioclase to sanidine ratio of about 2:1. It has given a K-Ar biotite age of 37.1±1.2 m.y. (Marvin and others, 1987). Tuff of Bishop Peak exposed in Bull Basin quadrangle contains highly argillized feldspar, making identification difficult, and the presence of sanidine uncertain. Thickness in Bull Basin quadrangle is less than 10 m to about 25 m

Contact—Dashed where approximately located or inferred; dotted where concealed

Fault—Dashed where approximately located or inferred; dotted where concealed; ball and bar on downthrown side; arrow indicates dip

Strike and dip of bedded rocks:
- Inclined
- Apparent strike and dip; if no number is shown, dip is less than 5°
- Horizontal or less than 5°

Strike and dip of flow structure in lava flows or compaction foliation in tuffs

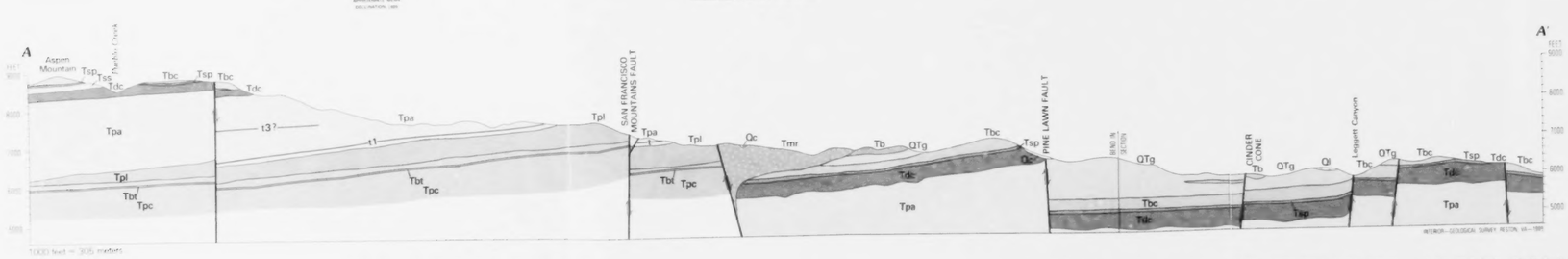
Sample localities:
- Dated samples—IV, VI, and VII are outside map area
- Chemically analyzed samples

Quartz vein—10-cm-thick vein west of Black Bull Saddle

Prospect—Bulldozer cut north of Lost Spring

Cinder cone—Along Saliz Canyon in southwest corner of quadrangle

Landslide or slump scarp



Base from U.S. Geological Survey, 1985
10,000-foot grid based on New Mexico coordinate system, central zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

SCALE 1:24 000
1 MILE
1 KILOMETER
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

NEW MEXICO
QUADRANGLE LOCATION

Geology mapped in 1977–78, 1986

Table 1.—*Chemical analyses of some volcanic rocks in or adjacent to the Bull Basin quadrangle, southwestern New Mexico*

[Sample localities shown on geologic map except as noted in footnotes. Values given in percent; < less than. Analyses by X-ray spectrometer. Project leaders: L. L. Jackson, J. E. Taggart, analysts: J. Anttti, A. Bartel, J. Baker, K. Stewart, J. Taggart, J. S. Wahlberg]

Map No.	1	2	3	4	5	6	7	8	9	10	11	12[1]	13	14	15
Field No.	L-3	88-186A-77	B-1-84	88-138-76	88-6-84	88-1-84	88-2-82	88-3-82	88-208-76	88-200-76	88-220C-76	88-168-76	88-1-82	88-14-82	88-152-76
Map Symbol	Tbt	Tpl	Tpa	Tdc	Tdc	Tba	Tmr	Tmr	Tmr	Tmr	Tmr	Tmr	Tss	Tss	Tss
Lab. No.	D-253481	D-225830	D-263287	263304	D-263301	D-263294	D-251016	D-263302	D-244951	D-244963	D-263303		D-263293	D-251035	D-263295
SiO_2	68.0	58.2	58.8	78.1	72.4	54.2	75.4	68.7	77.8	69.8	75.8	82.90	48.7	48.5	48.5
Al_2O_3	14.0	15.9	18.9	12.6	14.0	16.3	12.6	13.7	11.7	13.2	12.8	10.40	17.0	17.3	16.7
Fe_2O_3	2.17	6.17	6.42	0.95	1.67	7.46	1.12	3.10	0.97	2.96	1.15	5.39	12.5	12.2	11.9
FeO	0.07	0.08	0.12	0.04	0.07	0.1	0.04	0.08	0.05	0.07	0.05	0.10	0.18	0.18	0.19
MnO	0.78	2.9	2.27	<0.10	0.28	5.42	0.10	1.34	0.17	1.47	0.11	2.86	5.06	5.40	6.07
MgO	1.46	5.21	5.56	0.19	0.65	6.85	0.31	2.23	0.25	1.60	0.44	4.60	9.26	9.08	10.1
CaO	4.50	2.9	4.05	3.80	3.67	3.35	3.68	3.61	3.59	3.64	3.78	3.70	3.45	3.43	3.08
Na_2O	2.89	3.03	2.77	4.86	5.50	2.02	4.86	3.78	4.08	3.66	4.55	2.80	0.51	0.92	1.02
K_2O	0.43	0.84	0.75	0.14	0.32	1.14	0.07	0.42	0.08	0.42	0.07	0.80	1.98	1.85	1.86
TiO_2	0.07	0.2	0.34	<0.05	<0.05	0.46	<0.05	0.08	<0.05	0.07	<0.05	0.42	0.39	0.39	0.37
P_2O_5	0.07	0.2	0.34	<0.05	<0.05	0.46	<0.05	0.08	<0.05	0.07	<0.05	0.42	0.39	0.39	0.24
LOI	5.57	2.78	1.35	0.84	0.66	2.38	0.89	2.78	0.45	2.53	0.61	1.61	1.13	0.62	1.24
Total	99.32	99.28	99.27	99.57	99.47	99.68	99.12	99.82	99.13	99.54	99.42	100.28	100.12	100.07	100.53
SiO_2, Volatile free	71.81	60.99	60.05	78.92	73.27	55.7	76.81	70.79	78.85	72.03	76.72	83.93	48.69	48.87	48.34

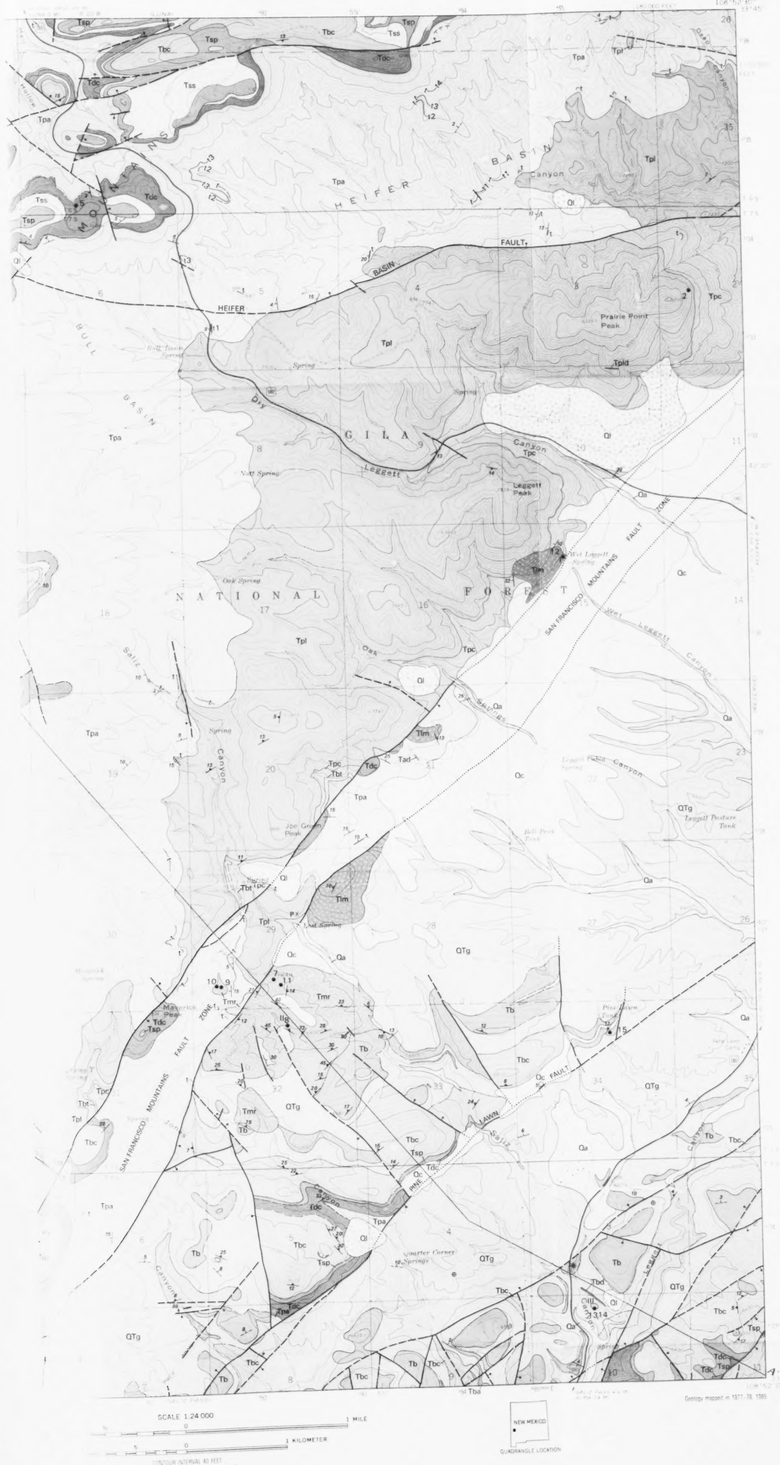
[1]Sample from Underwood Lake quadrangle, T. L. Finnell, written commun. (1984). [2]Sample from Saddle Mountain in Blue quadrangle. [3]Analyses published previously by Ratte and Gaskill (1975).

GEOLOGIC MAP OF THE BULL BASIN QUADRANGLE, CATRON COUNTY, NEW MEXICO

By
James C. Ratté

1989

GEOLOGIC QUADRANGLE MAP
BULL BASIN QUADRANGLE, NEW MEXICO
GQ-1651


Tsp
Tbc
Tss
Tpa
Tpl
Tpld
Tmv
Tbt
Tad
Tpc
Qa
Qc
Ql
QTg
Tbs
Tdc
Tsp
Tbc

GEOLOGIC MAP SYMBOLS

COMMONLY USED ON MAPS OF THE UNITED STATES GEOLOGICAL SURVEY

(Special symbols are shown in explanation)

Contact – Dashed where approximately located; short dashed where inferred; dotted where concealed

Contact – Showing dip; well exposed at triangle

Fault – Dashed where approximately located; short dashed where inferred; dotted where concealed

Fault, showing dip – Ball and bar on downthrown side

Normal fault – Hachured on downthrown side

Fault – Showing relative horizontal movement

Thrust fault – Sawteeth on upper plate

Anticline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric anticline – Short arrow indicates steeper limb

Overturned anticline – Showing direction of dip of limbs

Syncline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric syncline – Short arrow indicates steeper limb

Overturned syncline – Showing direction of dip of limbs

Monocline – Showing direction of plunge of axis

Minor anticline – Showing plunge of axis

Minor syncline – Showing plunge of axis

Strike and dip of beds – Ball indicates top of beds known from sedimentary structures

Inclined · Horizontal · Vertical · Overturned

Strike and dip of foliation

Inclined · Vertical · Horizontal

Strike and dip of cleavage

Inclined · Vertical · Horizontal

Bearing and plunge of lineation

Inclined · Vertical · Horizontal

Strike and dip of joints

Inclined · Vertical · Horizontal

Note: planar symbols (strike and dip of beds, foliation or schistosity, and cleavage) may be combined with linear symbols to record data observed at same locality by superimposed symbols at point of observation. Coexisting planar symbols are shown intersecting at point of observation.

Shafts

Vertical · Inclined

Adit, tunnel, or slope

Accessible · Inaccessible

Prospect

Quarry

Active · Abandoned

Gravel pit

Active · Abandoned

Oil well

Drilling · Shut-in · Dry hole abandoned

Gas · Show of gas

Oil · Show of oil

best copy available